Received 25 September 2021
Revised 22 November 2021
Accepted 9 March 2022

Unleashing family firms' potential to do more with less: product innovation efficiency, family involvement in TMTs and technological collaborations

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Abstract

Purpose – This paper aims to examine the influence of family involvement in TMTs on product innovation efficiency and the contingent role of technological collaborations, combining insights from the resource-based view and the behavioral agency model.

Design/methodology/approach – This study empirically develops and tests the hypotheses using a longitudinal sample of 3,852 firm-year observations from Spanish manufacturing firms over the period 2006–2016.

Findings – The results reveal that family involvement in TMTs positively influences product innovation efficiency. The results also show that such positive effect is weakened as technological collaborations increase, and varies according to the partner type with whom the cooperation agreement is established. Specifically, the findings indicate that collaboration with suppliers appear to be the least detrimental for product innovation efficiency in family firms, followed by collaborations with customers and research organizations.

Practical implications – Family firms should consider appointing family members to their TMT to improve product innovation efficiency. Moreover, to enhance the effect of family management on product innovation efficiency, family managers should carefully select their technological partners.

Originality/value – This study is one of the first studies to theoretically explain and empirically demonstrate that family involvement in TMTs is a critical antecedent of product innovation efficiency and that technological collaborations moderate such link. Moreover, this study goes further in revealing that distinct types of partners have a differential moderating influence on the family involvement in TMTs-product innovation efficiency relationship. The results can be used to help managers and practitioners to boost innovation performance as well as to assist policymakers to design firm-level innovation policies to improve family firms' competitiveness.

Keywords Product innovation efficiency, Family involvement in TMTs, Technological collaborations, Resource-based view, Behavioral agency model

Paper type Research paper

1. Introduction

Product innovation efficiency, which can be defined as a firm's ability to carry out product [1] innovations that exceed what would normally be expected from a given amount of R&D inputs (Cruz-Cázares *et al.*, 2013), is crucial to cope with shortening product life cycles and intense

Rubén Martínez-Alonso wants to acknowledge the funding received by the Spanish Ministry of Science and Universities in the form of a Research Grant to develop his PhD (FPU-17/01359), and thereby, this paper.

European Journal of Innovation Management
Vol. 25 No. 6, 2022
pp. 916-940
Emerald Publishing Limited
1460-1060
DOI 10.1108/EJIM-09-2021-0478

market competition in today's uncertain and rapidly changing environments (Calabrò *et al.*, 2019), and is considered essential to improve the performance and long-term survival of firms (Diéguez-Soto *et al.*, 2016). Recently, scholars have started to devote considerable attention to the role of family firms in (product) innovation efficiency (e.g. Casado-Belmonte *et al.*, 2021), given the prevalence of these businesses as the backbone of most industrialized and developed countries worldwide (Family Firm Institute, 2018). The central tenet of this research stream is that the idiosyncrasies of family firms render the transformation of innovation inputs into innovation outputs substantially more efficient, suggesting that family firms "do more with less" in their (product) innovation processes (Bendig *et al.*, 2020; Duran *et al.*, 2016; Matzler *et al.*, 2015).

However, little is known to date about the antecedents that encourage or hinder the ability of family firms to innovate (its products) more efficiently (Duran *et al.*, 2016; Manzaneque *et al.*, 2020). Previous research states that family involvement (in ownership and in management), conceived as a product of family relationships built over time (Colbert, 2004; Shinnar *et al.*, 2013), is a potential source of competitive advantage for innovation efficiency, as it brings high levels of family control over the firm (Gómez-Mejía *et al.*, 2007), more flexible organization structures and adjustable decision-making (Craig and Dibrell, 2006), less formalized processes (De Massis *et al.*, 2015) and the implementation of unique resource bundling processes (Carnes and Ireland, 2013). Specifically, family involvement in top management teams (TMTs) may be one of the most critical antecedents of innovation efficiency, insofar as family managers ensure active family participation in strategic decision-making processes related to innovation, their monitoring and execution (Migliori *et al.*, 2020). Nevertheless, family firms with family involvement in TMTs are heterogenous rather than homogenous group of entities, and thus, they are likely to differ in the way they conduct their product innovation processes (De Massis *et al.*, 2015). Unfortunately, research has overlooked the question of whether different levels of family involvement in TMTs drive heterogeneity in product innovation efficiency. To the best of the authors' knowledge, only the study of Martínez-Alonso *et al.* (2020), in a very exploratory and succinct manner and as a part of a mediation analysis, in which the focus is firm performance, examines the relationship between family management and technological innovation efficiency. Accordingly, there has been recent calls for investigations into the factors that shape the turning of innovation inputs into innovation outputs within family firms (Calabrò *et al.*, 2019; Duran *et al.*, 2016).

Moreover, further research is needed on the contingent factors that might moderate the influence of family involvement in TMTs on product innovation efficiency and, therefore, the extent to which the subsequent potential gains or losses of product innovation efficiency are shaped by other external agents. One of these key factors concerns technological collaborations, defined as voluntary agreements among independent businesses, who exchange and share resources such as capital, information, knowledge and technology to fulfill a common innovation goal (Un *et al.*, 2010). Despite being a decisive factor in supporting more efficient product innovations processes, research on technological collaborations in family firms is still in its infancy (Feranita *et al.*, 2017). The scarce previous literature on the subject has mainly focused on analyzing how certain family firms' characteristics, such as their resource endowments or risk aversion, affect the propensity of these firms to engage in collaboration agreements (Classen *et al.*, 2012; Lazzarotti *et al.*, 2017; Nieto *et al.*, 2015). However, there is a lack of in-depth empirical and theoretical knowledge on when and to what extent such collaborations may affect family involvement in TMTs in achieving product innovation efficiency, which is a relevant research gap for both scholarship and practice.

The main goal of this study is thereby to expand on previous research by examining the following research questions: (1) Does family involvement in TMTs influence product innovation efficiency? (2) Is the relationship between family involvement in TMTs and product innovation efficiency contingent upon technological collaborations? To examine these questions, we first rely on the resource-based view (RBV; Habbershon and Williams, 1999),

as family firms need to focus on identifying, managing and deploying potential idiosyncratic resources resulting from family involvement in TMTs (Habbershon and Williams, 1999; Sirmon and Hitt, 2003), in order to achieve sustained competitive advantages that support more efficient product innovation processes, and thus, remain competitive over time. Second, based on the behavioral agency model (BAM; Wiseman and Gomez-Mejía, 1998), which establishes that the behavior of the organization's dominant coalition (i.e. TMTs) affects corporate decision-making (Argote and Greve, 2007), we explore the extent to which technological collaborations influence family managers' strategic choices regarding the management of product innovation efficiency. From this perspective, we posit that the risks and costs inherent in collaboration agreements (e.g. opportunistic behaviors; Nieto and Santamaría, 2007) might condition family TMTs' behavior to place more emphasis on socioemotional wealth (SEW) preservation as a means of ensuring their control and influence on products' technological trajectories. Thus, by bridging insights from the RBV and BAM theories, we provide a more nuanced picture on the manners in which family managers conduct their product innovation efficiency in a collaborative setting. These theoretical predictions are tested in a longitudinal sample of 3,852 firm-year observations from Spanish manufacturing firms over the period 2006–2016.

Our paper makes several contributions to the academic literature. First, it contributes to open up the "black box" of family firm innovation by providing a clearer understanding of the antecedents that fuels family firms' ability to "do more with less" in their product innovation processes (Duran *et al.*, 2016). In this way, we shed new light on the significance of family involvement in TMTs to enhance internal functioning in product innovation processes and thus achieve more efficient transformations of innovation inputs into products innovations. Second, this study broadens the debate on heterogeneity in family firm innovation (Calabrò *et al.*, 2019), taking into account differences in product innovation efficiency according to the level of family involvement in TMTs. This study also extends the embryonic knowledge on technological collaborations in family firms (Feranita *et al.*, 2017), providing important insights into the role of collaborations as a contingent factor affecting family TMT involvement in shaping the efficiency with which innovation inputs are transformed into product innovations. Finally, this study is also pioneering in empirically demonstrating that technological collaborations exert differential moderating impacts on the family management-product innovation efficiency link, depending on the type of partner.

2. Theoretical background and hypotheses development

2.1 Family involvement in TMTs and product innovation efficiency

The RBV provides a suitable theoretical lens on family firm innovation behavior because it can help explain the complex nature of managing product innovation efficiency in a family firm context (Habbershon *et al.*, 2003; De Massis *et al.*, 2015). This RBV perspective implies that the confluence of family and business systems, gives rise to unique systemic conditions that generate an idiosyncratic set of intangible resources and capabilities (Habbershon and Williams, 1999), which affect the characteristics of technological innovation processes in family firms (De Massis *et al.*, 2013). Under this view, family involvement in the firm, understood as the product of complex and long-lasting structures, i.e. family relations (Colbert, 2004; Shinnar *et al.*, 2013), is among the most important family firms' resources that can lead to innovation-based competitive advantages and ultimately, to attractive performance outcomes (Yeniaras *et al.*, 2017), as it is unique, inseparable, synergistic and difficult to duplicate (Nordqvist, 2005).

The uniqueness of family involvement is considered a major driver of the well-known heterogeneous character of family firms (Chua *et al.*, 2012). Specifically, the varying forms and levels of family involvement can help to elucidate differences in family firms' behavior regarding product innovation strategies (Calabrò *et al.*, 2019). In this study, we argue that

family involvement in TMTs, rather than in ownership, is what drives the product innovation efficiency, not only because of its major implication on strategic decision-making and therefore, on firm (innovative) outcomes (Finkelstein *et al.*, 2009; Vandekerkhof *et al.*, 2019), but also because of its proven ability to increase the probability of maximizing the value of different inputs factors when undertaking technological innovation processes (Martínez-Alonso *et al.*, 2020). In this respect, differing levels of family involvement will shape the innovative strategic behavior of family firms' TMTs (Klein *et al.*, 2005; Ling and Kellermanns, 2010) and, thus, may directly influence the efficiency with which the product innovation process is conducted (De Massis *et al.*, 2015).

According to certain studies, family involvement in TMTs is viewed as a potential source of disadvantages for innovation, due, among other motives, to the family managers' common lack of professional competencies to innovate (Kotlar *et al.*, 2014a). Nevertheless, a flourishing body of research (e.g. Muñoz-Bullón *et al.*, 2020) strongly support that family firms' unique resources (e.g. tacit knowledge) lead to certain family-based competitive advantages that motivate family managers to ensure an efficient or parsimonious turning of innovation inputs into innovation outputs (Carney, 2005; Duran *et al.*, 2016). These advantages are even more pronounced as the dynamic interaction between the family and firm subsystems becomes more significant, that is, as the level of family involvement in TMTs increases (Le Breton-Miller *et al.*, 2011), given the crucial role of family managers in orchestrating firms' (innovation) resources (Sirmon *et al.*, 2011).

Family managers, who in most cases are involved in the business from an early stage, are endowed with deep, largely tacit knowledge of their firm's resources, routines, stakeholders and technologies (Nieto *et al.*, 2015). Due to its tacit component, this firm-specific knowledge is not codified and articulated without great effort and, thus cannot be easily replicated by others (Wong *et al.*, 2008). Such tacit knowledge, which is accumulated in the form of actions and experiences over a long period of time, supports knowledge transfer and mutual learning (Muñoz-Bullón *et al.*, 2020), and is found to enhance family managers' resource orchestration advantages for innovation (Duran *et al.*, 2016). Hence, a higher presence of family members in the TMT will bring to the firm deeper levels of tacit knowledge, leading to a greater efficiency in transforming R&D input into product innovation.

Another core element embedded in family managers is social capital, which comprises the resources associated with the firm's relationships with internal and external stakeholders (Arregle *et al.*, 2007). Within the firm, social capital enables family managers to maintain a cohesive and highly committed community of employees (Asaba and Wada, 2019), by developing trusting, sincere and close relationships with those employees (Gómez-Mejía *et al.*, 2007) and by using a distinctive family language (Tagiuri and Davis, 1996). Outside the organization, social capital helps family managers to foster and nurture greater quality, long-standing relationships with potential partners and also to enhance the success of alliances and partnerships (Zahra, 2005). Thereby, a large number of family members involved in TMTs will allow for more effective communication and information exchange (Tagiuri and Davis, 1996), facilitating better quality decision-making and therefore, greater product innovation efficiency (Martínez-Alonso *et al.*, 2020).

Moreover, there is an accumulated evidence advocating that family managers have less pressure for short-term payoffs (Rojo-Ramírez and Martínez-Romero, 2018), enabling them to expand their long-term view (Dunn, 1996). In this regard, having more family managers will imply a greater commitment to guarantee the continuity of the business in the long-term, which is beneficial to cover the time horizon required for innovation projects to be successful (Miller *et al.*, 2015), as well as to acquire the accumulated expertise and knowledge necessary to be progressively more efficient in product innovation management over the years (Daspit *et al.*, 2019). Likewise, as family participation in the TMT goes beyond decision-making to the execution of decisions, they may find it easier to adjust the course of unforeseen innovation

outcomes, helping to reduce potential losses (Kellermanns *et al.*, 2012). Therefore, a higher presence of family members in TMTs may favor family firms' innovative behavior, as they are more likely to recognize and comprehend the problems and chances that firms face (Zahra, 2005).

Based on the foregoing arguments, we postulated the following hypothesis:

H1. Higher levels of family involvement in the TMT enhance product innovation efficiency.

2.2 The moderating effect of technological collaborations

Technological collaborations with external partners are recognized as being beneficial for the firms' product innovation, since these partners provide the firm with the necessary resources (i.e. ideas, knowledge, experiences and technology) to innovate its products (Nieto and Santamaría, 2007; Un *et al.*, 2010; among several others). RBV scholars argue that collaborations are valuable resources to overcome innovation barriers (e.g. resource limitations shaped by governance structures), exploiting synergies from resource complementarities between partners, and an important source of competitive advantage for family firm innovation (Das and Teng, 2000; Feranita *et al.*, 2017).

Nevertheless, in contrast to this RBV viewpoint, a vast majority of studies (e.g. Bigliardi and Galati, 2018) have revealed that, while family firms are able to manage promising collaboration projects, they are generally unwilling to open the product innovation process to the external world (De Massis *et al.*, 2015). The underlying reason for this unwillingness is that family managers may be firmly reluctant to let new actors (e.g. suppliers) from outside the business sphere gain the ability to exercise some influence and control over the technological trajectory of products (Almirall and Casadesus-Masanell, 2010; De Massis *et al.*, 2015), as this would put their accumulated endowment of SEW at risk. The concept of SEW, which is a derivation of BAM, refers to a collective set of family's affective needs, such as sense of identity, ability to exercise family influence and the perpetuation of the family dynasty (see Gómez-Mejía *et al.*, 2007, for an overview). Through the BAM, Gómez-Mejía *et al.* (2007) proved that to protect non-financial benefits, family firms are willing to accept increased risks, because when the family's SEW is threatened, family managers are likely to make decisions that are not guided by economic rationality. In this light, BAM research has shown that SEW preservation constitutes the pivotal point of reference that drives strategic decision-making in family firms (Zellweger *et al.*, 2013). Therefore, when making strategic decisions, family managers typically face a trade-off between the overlapping and sometimes competing rational and emotional considerations (Kotlar *et al.*, 2020). This interplay of objectives has been identified as a key determinant of TMTs heterogeneity, which conditions family managers' behavior regarding strategic choices (Kotlar *et al.*, 2014b), including the searching for technological collaborations (Classen *et al.*, 2012). More precisely, a higher number of family members in TMTs are expected to increase the emphasis on family goals and values in an attempt to protect SEW (Gómez-Mejía *et al.*, 2007), making the decision to open up the product innovation process a very challenging issue.

Technological collaborations restrict the pool of available resources and may therefore directly threaten family managers' autonomy to allocate them to product innovations according to their personal criteria (Carney, 2005). While the family managers' freedom to allocate resources intuitively can be favorable in certain contexts characterized by, for example, organizational innovation, collaborators may find this inadequate for conducting business (Nieto *et al.*, 2015). In addition, collaborations can give rise to opportunistic behaviors (such as shirking, cheating and appropriating resources and knowledge, etc.) and appropriability hazards due to the existence of information asymmetries between partners (Wu, 2012), often unavoidable given the difficulty of bearing the higher costs associated with searching, contracting and monitoring these processes (Pisano, 1990). The inability to effectively supervise collaborators, together with the uncertain nature of these activities, can

make it difficult for family managers to take advantage of their social capital and thus, to benefit from such cooperation agreements (Gjergji *et al.*, 2019).

Moreover, collaborations require joint planning activities, which may oblige family managers to reveal strategically valuable information and give power to professional agents with the necessary technical background and expertise to manage these activities (Kotlar *et al.*, 2014b). In this context, collaborations might provoke knowledge leakages as family managers would have to disclose firm-specific confidential information, like know-how and technologies, to outside actors (Cassia *et al.*, 2012), damaging their intrinsic tacit knowledge and in turn, the efficiency with which they obtain product innovations. Likewise, collaborations might exacerbate the limited family managers' ability to assimilate and manage external knowledge, namely their absorptive capacity, hampering the possibility of extracting any value from innovations (Pellegrini and Lazzarotti, 2019).

On the other hand, collaborations may foster the risk-averse climate that often permeates family firms' decisions concerning product innovation given that, even when engaging in collaboration, family managers prioritize the firm continuity and survival in the long-term over short-term payoffs (Lambrechts *et al.*, 2017). Similarly, collaborations could boost the not-invented-here syndrome (Katz and Allen, 1982). This is a cultural aspect that leads to a negative attitude toward the acquisition of new ideas or technologies (Antons and Piller, 2015), and which seems to be quite propitious in a family firm context (König *et al.*, 2013), because of the psychological preconceptions of family managers toward external knowledge inputs. Finally, collaborations might compromise the identity aspect of SEW, inasmuch as less family managers' control over the entire technical development path of products can seriously weaken the connection between the family name and the firm product (Kotlar *et al.*, 2013).

Taken together, these arguments suggest that technological collaborations could undermine family managers' competitive advantages to innovate and therefore, their ability to efficiently conduct the product innovation process. Stated formally:

H2. Technological collaborations will moderate the relationship between family involvement in the TMT and product innovation efficiency, such that family involvement in the TMT will have a less intense influence on product innovation efficiency as collaborations increase.

2.3 The moderating effect of technological collaborations with different types of partners

That said, it must be recognized that all collaborators are not equal (O'Connor *et al.*, 2021). Prior literature indicates that each partner type (e.g. customers) has its own priorities and goals, varies considerably in the nature and breadth of the transferred knowledge and plays different roles through the product innovation process (Hsieh *et al.*, 2018), which in turn may lead to varying levels of family losses in terms of SEW (De Massis *et al.*, 2015). For example, customers and competitors may give firms a better understanding of the market whereas suppliers and research organizations may help solve troubles or identify new possibilities for the firm to explore (O'Connor *et al.*, 2021). Therefore, one can expect that each partner type will exercise a distinctive impact on family managers' ability to achieve product innovation efficiency. For purposes of conciseness, our study focuses on four usual collaborators: suppliers, customers, competitors and research organizations. Herein, based on the collaborators' divergent set of goals, knowledge and roles regarding the product innovation process, we go further and analyze the specific moderating effect of each collaborator on the family management-product innovation efficiency relationship.

Vertical collaborations (with suppliers and customers) are often the most established product innovation link for business to business relationships (Nieto and Santamaría, 2007). Collaboration with suppliers implies adjustments in firms' value chains, for example by having to outsource

part of the product development process, generally that related to the input side (Arranz and de Arroyabe, 2008). This entails a direct loss of family managers' autonomy in the conversion of raw materials and in the assignment of components parts or subsystems to product innovations, as some of the choices they previously made will now be taken by independent firms that are likely to maximize their payoffs (Almirall and Casadesus-Masanell, 2010). Moreover, collaboration with suppliers usually triggers personnel exchanges between the supplier and the customer as a mechanism to ensure knowledge sharing (Takeishi, 2002). Such staff exchanges could be a potential way for the supplier to gain insights into family managers' deeper firm-specific knowledge and efficiency targets, and how these are assessed internally (Un and Asakawa, 2015). Accordingly, as suppliers gain control in the early stages of the product's technological trajectory, family managers will have more difficulties in keeping their autonomy and tacit knowledge, and thus, their product innovation efficiency may be diminished.

Collaboration with customers involves the active participation of end-users in the product innovation process, for example by developing or modifying products based on the knowledge of their unmet preferences and needs (Chatterji and Fabrizio, 2014). These preferences and needs, which are deeply rooted in customers, may not be obvious even to them, but are acted upon when they buy the products (Un *et al.*, 2010). In this setting, the limited family managers' absorptive capacity may hamper their ability to identify and therefore, assimilate and exploit latent customer needs (Tsai, 2009). This may increase family managers' reluctance to work with customers, inasmuch as such managers will be unable to know with certainty their customer needs and how to satisfy them, which in turn, could reduce the likelihood of successful product innovations (Kärkkäinen and Elfvengren, 2002). These arguments, coupled with the fact that collaboration with customers may influence product attributes (e.g. functional characteristics and properties) and personality (e.g. the message that the product explicitly communicates to the end-user), may cause a deterioration in family managers' bond and attachment to the product in question, and thus compromise the efficiency with which such product innovation is conducted.

Collaboration with competitors seems to be the least conducive to product innovation processes (Bayona-Sáez *et al.*, 2003). This is because relations between competitors are unstable and dynamic by nature, provoking high levels of tension in firms (Gnyawali and Park, 2011). Thus, such partner is expected to aggravate all problems associated with opportunistic behavior and information leakages, and the risks of misappropriation and hold-up is greater with competitors (Nieto and Santamaría, 2007). Furthermore, competitors will actively block the transfer of new knowledge to direct rivals, due to it could reinforce the latter's advantages to better fulfill the needs of their similar customers (Un *et al.*, 2010). Thereby, unless such collaboration is limited to solving shared problems outside the competitor's area of influence, such as regulatory changes or standard setting (Tether, 2002), it might undermine family managers' potential to achieve enhanced product innovation efficiency.

On the contrary, collaboration with research organizations is believed to focus on more (exploratory) basic and precompetitive research (Galati and Bigliardi, 2017). Indeed, as a driving force in basic research, it provides firms with a broader knowledge aimed at improving product innovation (Un *et al.*, 2010). Consequently, collaboration with this partner urges family managers to enhance some core competencies, such as absorptive capacity, to acquire knowledge that although easily accessible, is certainly complex to assimilate and decode (Pellegrini and Lazzarotti, 2019). In addition, the incentives and foci of research organizations (e.g. investigation in multiple disciplines or dissemination of knowledge) are likely to differ considerably from those of family managers (Steinmo and Rasmussen, 2016). This modus operandi, in conjunction with the expected complexity of internalizing such

complex knowledge, may weaken the product innovation efficiency obtained by family managers.

All of the above leads us to hypothesize that:

H3. Technological collaborations with different types of partners, namely (a) suppliers, (b) customers, (c) competitors and (d) research organizations, will moderate the relationship between family involvement in TMTs and product innovation efficiency, and such interaction effects will vary according to the type of partner selected.

3. Methodology

3.1 Sample and measures

The sample used consists of a longitudinal panel data set of 3,852 firm-year observations throughout a 11-year period (2006–2016) drawn from the Spanish Survey on Business Strategies (SSBS). The SSBS is an annual survey conducted by the SEPI Foundation in cooperation with the Spanish Ministry of Industry. The SSBS was developed with the aim of ensuring the representativeness of the Spanish manufacturing industry. The reference population are those firms with 10 or more employees dedicated to one of the activities pertaining to divisions 10 to 32 of the CNAE-2009 classification, excluding division 19 (activities related to oil refinery and fuel processing). Firms included in the SSBS are selected by combining random sampling (firms with 10–200 employees) and census systems (firms with more than 200 employees). Over the years, certain firms leave the sample and are replaced by other firms to prevent population reductions across industries and size segments. The general response rate has ranged from 81% to 95%, and the different sections of the survey are completed by an average of 2.5 individuals in each firm. Thus, considering both the numerous efforts to minimize sample deterioration and the high response rate, nonresponse bias is not a significant concern. Moreover, all information within the SSBS is subject to quality, consistency and validation controls along time.

The SSBS focus on the manufacturing industry is regarded quite appropriate for our study, since the usual high level of obsolescence of manufacturing firms' products due to, among other factors, their progressively shorter life cycles (Kotlar *et al.*, 2014b), suggests that product innovation efficiency is likely to be utilized in the pursuit of sustained competitive advantages. Furthermore, albeit families operate in a wide range of firms, family firms seem to be a very prevalent organizational form among manufacturing firms (Diéguez-Soto *et al.*, 2016).

Table 1 provides definitions of the variables used in the empirical analysis. Dependent (product innovation efficiency) and independent (family involvement in TMTs) variables require further explanation.

Product innovation refers to the firm's introduction of completely new products or major changes that make them distinct from formerly manufactured products. Particularly, we assess product innovation in terms of the number of new products obtained, which is a reliable and critical indicator of a firm's product innovation activities (Sánchez-Marín *et al.*, 2020; Un *et al.*, 2010). In this study, we measure the product innovation efficiency as the ratio between the number of product innovations to the number of firms' R&D employees with the aim of capturing the efficiency with which firms turn R&D input into product innovation output. This measurement implies the assumption that product innovation efficiency increases when (1) fewer R&D employees lead to the same number of product innovations or (2) the same number of R&D employees lead to a higher number of product innovations.

According to a large volume of research (e.g. Kotlar *et al.*, 2014b), a family controls the firm when its members actively participate in ownership and management. The SSBS

Variable	Definition	References
Panel A. Dependent variable		
Product innovation efficiency	It is measured as the division between the number of product innovations and the number of firms' R&D employees	Martínez-Alonso *et al.* (2020)
Panel B. Independent and moderating variables		
Family involvement in TMTs	It is measured as the number of family members who occupy positions in the TMT	Kotlar *et al.* (2013)
Technological collaborations	It is measured as the number of technological collaborations that a firm develops with different types of partners (suppliers, customers, competitors and research organizations). This variable ranges from 0 (a firm does not collaborate with any partner) to 4 (a firm collaborates with all partners)	Classen *et al.* (2012)
Collaboration with suppliers	A dummy variable indicating whether the firm develops technological collaboration with suppliers (1 = Yes; 0 = No)	Bodas-Freitas and Fontana (2018)
Collaboration with customers	A dummy variable indicating whether the firm develops technological collaboration with customers (1 = Yes; 0 = No)	Un *et al.* (2010)
Collaboration with competitors	A dummy variable indicating whether the firm develops technological collaboration with competitors (1 = Yes; 0 = No)	Hsieh *et al.* (2018)
Collaboration with research organizations	A dummy variable indicating whether the firm develops collaboration with universities and/or technological centers (1 = Yes; 0 = No)	Tsai (2009)
Panel C. Control variables		
Firm size	It is measured as the natural logarithm of the number of employees	Alberti *et al.* (2014)
Generational stage	A dummy variable indicating whether the firm is less than 25 years old (first generation business) (1 = Yes; 0 = No)	Arrondo-García *et al.* (2016)
Past firm performance	It is measured as the difference between sales and the cost of goods sold scaled by sales in $t-1$	De Massis *et al.* (2018)
Financial aid for innovation	A dummy variable indicating whether the firm has received financial aid for innovation (1 = Yes; 0 = No)	Raymond *et al.* (2010)
Firm leverage	It is measured as the ratio of total debt to total assets	Matzler *et al.* (2015)
Process innovation	A dummy variable indicating whether the firm introduces new or significantly improved production processes (1 = Yes; 0 = No)	Un and Asakawa (2015)
Territorial subdivisions (NUTS1)[a] dummies	1. Northwest; 2. Northeastern; 3. Madrid; 4. Center; 5. East; 6. South; and 7. Canarias	Manzaneque *et al.* (2020)
Industry dummies	1. Meat industry; 2. Foodstuffs and snuff; 3. Drinks; 4. Textiles and clothing; 5. Leather and footwear; 6. Timber industry; 7. Paper industry; 8. Graphics; 9. Chemical and pharmaceutical products; 10. Rubber and plastic; 11. Non-metallic mineral products; 12. Ferrous and nonferrous metals; 13. Metal products; 14. Agricultural and industrial machinery; 15. Computer, electronic and optical products; 16. Electrical machinery and material; 17. Motor vehicles; 18. Other transport equipment; 19. Furniture industry; and 20. Other manufacturing	Diéguez-Soto *et al.* (2018)

Table 1.
Definition of variables

Note(s): [a]NUTS1: Nomenclature des Unités Territoriales Statistiques. Eurostat: http://ec.europa.eu/eurostat/web/nuts/overview (Accessed 5 of July of 2021)

provides for all family firms the number of owners and their immediate relatives who hold positions in TMTs. Hence, we define the level of family involvement as a continuous variable counting the number of family members in the firm TMT. This is an objective measure of family involvement in TMTs, coherent with previous family firm studies (Kotlar *et al.*, 2013; Manzaneque *et al.*, 2020) and suitable for testing the proposed hypotheses.

3.2 Controlling for endogeneity

We use two sequential steps to control for possible endogeneity of family involvement in TMTs due to unobservable organizational or environmental characteristics not captured by the control variables, or reverse causality between independent and dependent variables. First, we employed longitudinal data and applied a 1-year lag between the dependent variable and the rest of variables to ensure the direction of causality and mitigate the likelihood of reverse causality. Second, we implemented Heckman's (1979) two-stage technique (e.g. Gómez-Mejía *et al.*, 2007). Using Heckman's two-stage procedure, we first run a probit model in which the endogenous variable is the family firm (= 1) versus non-family firm (= 0) and estimate the inverse Mills ratio. We then run the regression models of product innovation efficiency using the inverse Mills ratio from the first-stage model as an additional control.

We used three instrumental variables in the first-stage model that may affect the likelihood of family control, but are not correlated with product innovation efficiency. The first instrumental variable is the number of family members working as employees in the business, as having family members as employees raises the gains that a family may obtain from controlling a firm (Kotlar *et al.*, 2014a). Furthermore, in line with previous family and innovation studies (Fang *et al.*, 2021; Muñoz-Bullón *et al.*, 2020), the share of both industry sales and regional sales from family firms were also included as instrumental variables. These variables should be related to the probability that a firm in the industry is a family firm, but should be independent of product innovation efficiency as the latter is industry-adjusted.

3.3 Analytical method

Given that our dependent variable (product innovation efficiency) is left-censored, i.e. it only presents positive values and contains several observations with values equal to 0, a Tobit panel data approach is most appropriate to check our hypotheses (Grimpe and Kaiser, 2010). Tobit models rightly address this particular aspect of our data by treating firms with no product innovation efficiency distinctly different from firms with product innovation efficiency. Specifically, we employ random-effects Tobit models. The alternative fixed-effects approach is not feasible in this case due to some key control variables in our model, such as industry dummies, are invariant over time for each firm in the sample (Ashwin *et al.*, 2015; Kennedy, 1998). Since our data set is longitudinal in nature, this model, in addition to allow measuring the incidence of observable variables on product innovation efficiency, also measures the impact of non-observable ones. Our model has the following analytical specification:

$$y_{it} = \left\{ \begin{array}{ll} \beta' x_{it-1} + u_{it}, \quad i = 1, 2, \ldots, N; \quad t = 1, 2, \ldots, T & \text{if} \quad y_{it}^{*} > 0 \\ 0 & \text{Otherwise,} \end{array} \right\} \tag{1}$$

Where y_{it} is a latent variable reflecting firm i's product innovation efficiency level at time t, y_{it}^{*} is the unobserved (latent) variable that measures each firm's real product innovation efficiency, x_{it-1} is a vector of relevant firm factors to explain the extent of product innovation efficiency, β is a vector representing the parameters to be estimated and u_{it} is the error term.

This error term is defined as follows: $u_{it} = v_i + e_{it}$, being the former element (v_i) a firm-specific unobservable effect that captures all unobserved, time-constant characteristics affecting product innovation efficiency. The latter element (e_{it}), frequently named as the idiosyncratic or time-varying error, accounts for the unobserved aspects that vary over time and impact on product innovation efficiency. This model will thus estimate β to more accurately capture the effect of regressors on product innovation efficiency.

Moreover, since correcting for self-selection of family control is of great theoretical importance (Chrisman and Patel, 2012); we incorporate the inverse Mills ratio from the first-stage model into the product innovation efficiency models. The non-significance of the inverse Mills ratio in the second stage denotes that the potential endogeneity of family control did not negatively influence the estimated results on product innovation efficiency. The hypothesized results are similar with and without the presence of the inverse Mills ratio.

4. Results

4.1 Descriptive statistics and correlations

Table 2 shows the means, standard deviations and correlations for the variables used in this study. Modest correlation values among our variables are revealed. The highest correlation coefficient is below the problematic level of 0.80 (Gujarati and Porter, 2008), thus suggesting low multicollinearity hazards. Furthermore, to check for moderation and reduce the potential problem of multicollinearity, the independent variable was mean-centered before generating the interaction terms (Aiken and West, 1991).

4.2 Results from regression analyses

Table 3 presents the regression results for the influence of family involvement in TMTs on product innovation efficiency and the moderating effect of technological collaborations. Model 1 includes the control variables and the estimation of the main effect. Family involvement in TMTs is positively and significantly associated with product innovation efficiency ($\beta = 0.398$; $p < 0.05$), demonstrating that growing levels of family involvement in TMTs are related to greater product innovation efficiency, thereby supporting H1.

In Model 2, we add the variable technological collaborations. The results show a positive and significant direct effect of such collaborations on the dependent variable ($\beta = 0.416$; $p < 0.05$). Nevertheless, since our main objective is to analyze when and to what extent technological collaborations affects the family management-product innovation efficiency relationship, Model 3 introduces the interaction term between technological collaborations and family involvement in TMTs. The coefficient of the interaction term is negative and significant for the dependent variable ($\beta = -0.407$; $p < 0.01$). We thus find support to H2. To better interpret our significant moderating effect (Dawson, 2014), in Figure 1, we illustrate the interaction by estimating the predicted product innovation efficiency of firms under different conditions (low and high values of family involvement in TMTs and low and high values of technological collaborations). Figure 1 displays that product innovation efficiency is higher in the presence of high family involvement in TMTs and low technological collaborations.

Table 4 presents the regression results for the moderating effects of collaborations with suppliers, customers, competitors and research organizations. Model 4 adds the direct effects of collaborations with these partners and shows that collaboration with suppliers has a significant positive impact on product innovation efficiency ($\beta = 1.322$; $p < 0.01$), while collaborations with customers, competitors and research organizations does not exert significant influence on the dependent variable. Then, Models 5, 6, 7 and 8 introduce the interaction terms between collaborations with suppliers, customers, competitors, and

Table 2.
Descriptive statistics and correlation matrix

	Mean	SD	1	2	3	4	5	6	7	8	9	10	11	12
1. Product innovation efficiency	0.54	2.83												
2. Family involvement in TMTs	0.73	1.08	0.05***											
3. Technological collaborations	1.66	1.20	0.01*	−0.13***										
4. Collaboration with suppliers	0.56	0.49	0.03**	−0.08***	0.77***									
5. Collaboration with customers	0.46	0.50	0.03*	−0.10***	0.76***	0.48***								
6. Collaboration with competitors	0.07	0.25	−0.03**	−0.06***	0.44***	0.19***	0.22***							
7. Collaboration with research organizations	0.58	0.50	−0.01	−0.11***	0.65***	0.27***	0.23***	0.16***						
8. Firm size	5.12	1.31	−0.09***	−0.29***	0.34***	0.24***	0.14***	0.24***	0.31***					
9. Generational stage	0.33	0.47	0.04**	−0.08***	−0.01	−0.02	0.02	0.03	−0.02	−0.07***				
10. Past firm performance	0.25	0.12	−0.03**	0.10***	−0.03**	−0.04**	0.02	−0.04**	−0.05***	−0.16***	−0.04**			
11. Financial aid for innovation	0.28	0.44	0.01	−0.01	0.34***	0.22***	0.17***	0.19***	0.34***	0.23***	−0.02	0.02		
12. Firm leverage	0.51	0.22	0.01	−0.07***	0.05***	0.02	0.01	0.08***	0.06***	0.17***	0.07***	−0.24***	0.05***	
13. Process innovation	0.68	0.56	0.01*	−0.01	0.20***	0.18***	0.11***	0.08***	0.14***	0.13***	−0.05***	−0.01	0.10***	−0.01

Note(s): N (observations) = 3,852; SD = Standard deviation; $^{*}p < 0.10$. $^{**}p < 0.05$. $^{***}p < 0.01$

DV: product innovation efficiency	Model 1	Model 2	Model 3
Main effect			
Family involvement in TMTs	0.398** (0.192)	0.409** (0.192)	1.068*** (0.294)
Moderator			
Technological collaborations		0.416** (0.166)	0.352** (0.168)
Interaction effect			
Technological collaborations * family involvement in TMTs			−0.407*** (0.137)
Controls			
Firm size	0.189 (0.257)	0.071 (0.261)	0.081 (0.260)
Generational stage	1.079** (0.490)	1.086** (0.488)	1.103** (0.488)
Past firm performance	−1.500 (1.618)	−1.571 (1.615)	−1.742 (1.615)
Financial aid for innovation	1.158*** (0.412)	1.056*** (0.413)	1.139*** (0.412)
Firm leverage	0.617 (1.019)	0.582 (1.018)	0.499 (1.017)
Process innovation	1.791*** (0.354)	1.715*** (0.355)	1.725*** (0.354)
Territorial subdivisions	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes
Inverse mills ratio	−0.059 (0.374)	−0.044 (0.373)	−0.079 (0.373)
Intercept	−7.520*** (1.514)	−7.542*** (1.510)	−7.460*** (1.508)
Number of observations	3,020	3,020	3,020
Wald chi-square	59.61***	65.86***	74.28***
Log likelihood	−4536.295	−4533.152	−4528.739
Likelihood ratio test	472.46***	466.25***	462.43***

Note(s): DV: Dependent variable; Standard errors in parentheses; *$p < 0.10$. **$p < 0.05$. ***$p < 0.01$

Table 3.
Direct influence of family involvement in TMTs on product innovation efficiency and moderating effect of technological collaborations

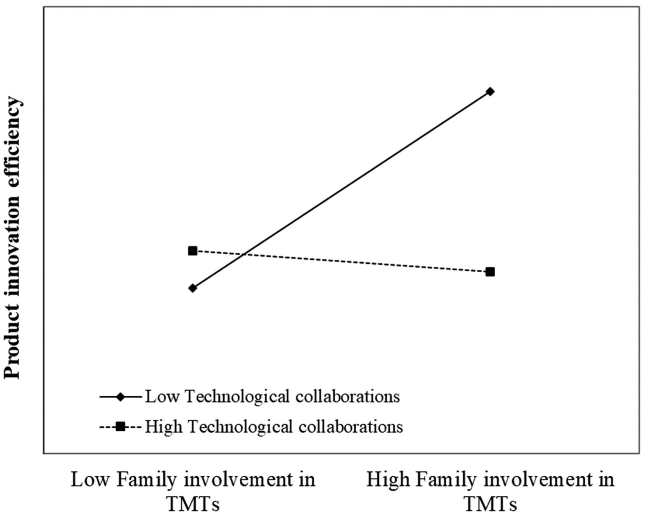

Figure 1.
Interaction: technological collaborations × family involvement in TMTs

research organizations and family involvement in TMTs, with the coefficients of these terms being significant in the case of suppliers, customers and research organizations, and non-significant for competitors. Hence, we find support for H3a, H3b and H3d, but reject H3c. Additionally, suppliers are found to be the partners with the least negative and significant

Table 4. Moderating effects of collaborations with different types of partners on the family involvement in TMTs-product innovation efficiency relationship

DV: product innovation efficiency	Model 4	Model 5	Model 6	Model 7	Model 8
Main effect					
Family involvement in TMTs	0.414** (0.192)	0.705*** (0.251)	0.790*** (0.242)	0.450** (0.194)	0.897*** (0.268)
Moderators					
Collaboration with suppliers	1.322*** (0.419)	1.293*** (0.419)	1.347*** (0.419)	1.306*** (0.419)	1.293*** (0.418)
Collaboration with customers	0.022 (0.422)	0.027 (0.422)	0.173 (0.427)	0.025 (0.422)	0.013 (0.422)
Collaboration with competitors	−0.629 (0.665)	−0.696 (0.666)	−0.740 (0.666)	−0.983 (0.733)	−0.655 (0.664)
Collaboration with research organizations	0.168 (0.429)	0.169 (0.429)	0.185 (0.429)	0.180 (0.429)	0.087 (0.431)
Interaction effects					
Collaboration with suppliers * family involvement in TMTs		−0.535* (0.301)			
Collaboration with customers * family involvement in TMTs			−0.798** (0.317)		
Collaboration with competitors * family involvement in TMTs				−0.898 (0.718)	
Collaboration with research organizations * family involvement in TMTs					−0.859*** (0.335)
Controls					
Firm size	0.061 (0.261)	0.047 (0.261)	0.063 (0.261)	0.076 (0.262)	0.081 (0.261)
Generational stage	1.115** (0.488)	1.078** (0.488)	1.147** (0.488)	1.144** (0.489)	1.153** (0.488)
Past firm performance	−1.531 (1.611)	−1.673 (1.613)	−1.573 (1.611)	−1.565 (1.612)	−1.559 (1.612)
Financial aid for innovation	1.091*** (0.413)	1.115*** (0.413)	1.153*** (0.414)	1.095*** (0.413)	1.086*** (0.413)
Firm leverage	0.656 (1.017)	0.671 (1.016)	0.588 (1.017)	0.616 (1.017)	0.594 (1.017)
Process innovation	1.673*** (0.355)	1.666*** (0.355)	1.702*** (0.355)	1.679*** (0.355)	1.659*** (0.354)
Territorial subdivisions	Yes	Yes	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes	Yes	Yes
Inverse mills ratio	−0.018 (0.373)	−0.020 (0.373)	−0.003 (0.373)	−0.054 (0.375)	−0.051 (0.374)
Intercept	−7.682*** (1.511)	−7.589*** (1.510)	−7.749*** (1.511)	−7.666*** (1.511)	−7.687*** (1.511)
Number of observations	3,020	3,020	3,020	3,020	3,020
Wald chi-square	72.67***	75.66***	78.69***	74.01***	79.02***
Log likelihood	−4529.591	−4528.007	−4526.408	−4528.883	−4526.299
Likelihood ratio test	461.42	457.48	457.60	459.59	463.34

Note(s): DV: Dependent variable; Standard errors in parentheses; *$p < 0.10$. **$p < 0.05$. ***$p < 0.01$

moderating effect (Model 5, $\beta = -0.535$; $p < 0.10$), followed by customers (Model 6, $\beta = -0.798$; $p < 0.05$) and research organizations (Model 8, $\beta = -0.859$; $p < 0.01$), respectively. Figure 2 provides a graphical representation of the resulting significant interaction terms.

5. Discussion and conclusions

5.1 Discussion of results

Academics have embarked on a vigorous debate about the antecedents of innovation efficiency, with particular emphasis on unleashing family firms' innovative potential (Duran *et al.*, 2016; Manzaneque *et al.*, 2020). Contributing to this debate, we aimed to explain the manners in which the level of family involvement in TMTs influences product innovation efficiency. In view of the important role that technological collaborations play throughout the product innovation process (Nieto and Santamaría, 2007), we investigated whether and to what extent collaborations (1) with external partners, and more specifically, (2) with suppliers, customers, competitors and research organizations, moderate the relationship between family involvement in TMTs and product innovation efficiency. This article deals with these issues and offers new insights using a sample of 3,852 firm-year observations from Spanish manufacturing firms.

Our first result confirms that increased levels of family involvement in TMTs are positively associated with product innovation efficiency. This result is in line with the literature arguing that family involvement in the TMT is beneficial for innovation efficiency, as family managers may leverage their tacit knowledge, social capital and sense of long-term commitment to strongly support more efficient technological innovation processes (Muñoz-Bullón *et al.*, 2020).

Our second result verifies our theorizing that technological collaborations weaken the positive link between family involvement in TMTs and product innovation efficiency. This result suggests that the underlying risks and costs of collaboration agreements (e.g. loss of managerial autonomy over products' technological path) could be greatly magnified by family managers when achieving product innovation efficiency, due to the greater families' concern for preserving SEW (Gómez-Mejía *et al.*, 2007). In this light, collaborations might diminish the effectiveness of family managers' unique resources (e.g. social capital) that fuel firms' ability to innovate their products efficiently.

Our third result refers to the moderating effect of collaborations with different partner types, namely suppliers, customers, competitors and research organizations, individually considered. On the one hand, our results show that collaborations with suppliers, customers and research organizations weaken the family management-product innovation efficiency link. Moreover, research organizations emerge as the partner type that exerts the most detrimental moderating effect, followed by customers and suppliers in order of importance. These findings are coherent with prior literature indicating that family firms appear to be more favorable to opening up their innovation processes to customers and suppliers as opposed to other collaboration forms (Pellegrini and Lazzarotti, 2019), since suppliers and customers are the collaborators who less damage SEW preservation (De Massis *et al.*, 2015). On the other hand, our results show that collaboration with competitors does not moderate the family management-product innovation efficiency relationship. One potential explanation for this non-finding could be that firms have established formal knowledge protection mechanisms to protect themselves from competitors' threats (O'Connor *et al.*, 2021).

5.2 Theoretical implications

This study makes several important contributions to the literature. It complements and extends the ongoing debate on family firm innovation by offering evidence on the potential of

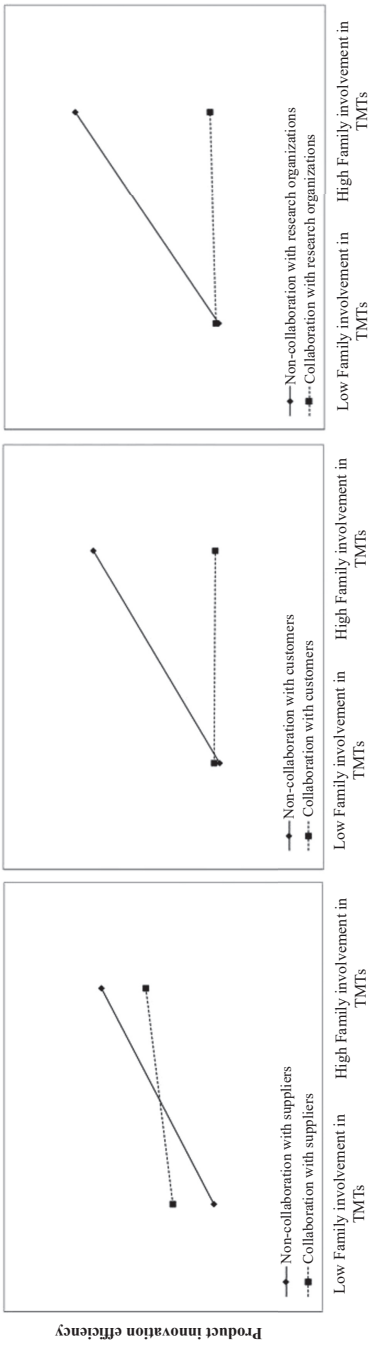

Figure 2.
Interactions: collaboration with suppliers, customers and research organizations × family involvement in TMTs

business families to "do more with less" in their technological innovation processes (Bendig *et al.*, 2020; Duran *et al.*, 2016). Building on RBV, we substantiate this assumption by examining the influence of family involvement in TMTs on product innovation efficiency. Notably, we argue that family involvement in TMTs represents the governance mechanism that allows for major family participation on strategic decision-making concerning innovation, thus exerting the most significant influence on product innovation processes. Specifically, we theorize that growing levels of family involvement in TMTs enhance the endowment and leverage of the unique resources (i.e. tacit knowledge, social capital, sense of long-term commitment) of family managers, and thus potentially help family firms to achieve greater product innovation efficiency. This is an important contribution to research on family firm innovation, as it underlines that successful product innovation processes require the implication and participation of all family TMT members, thus revealing new theoretical insights into the role of families in shaping the future technological trajectories of their firms' products.

Our study also enriches the lively discussion on heterogeneity among family firms (Chua *et al.*, 2012) by identifying family involvement in TMTs as a powerful source of variability in family firms' innovation behavior (e.g. Calabrò *et al.*, 2019). Family involvement in TMTs differs within family firms and may change over time (Nordqvist *et al.*, 2014), which means that the most suitable resources for achieving greater efficiency in the conversion of innovation inputs into product innovations are likely to vary across family firms at any one time and within a business through time. We thus provide a more complete picture of the heterogeneous innovation behavior of family firms in terms of management (Nieto *et al.*, 2015), contributing to the recent and scarce research on family involvement in TMT as an antecedent of innovation (Kammerlander *et al.*, 2020).

This study also contributes to broaden the emerging research stream on technological collaborations in family firms (Feranita *et al.*, 2017). Prior literature has shown that technological collaborations can be a double-edged sword with both positive and negative effects for family firm innovation (Bigliardi and Galati, 2018). While RBV theorists often find in collaborations critical resources to provide competitive advantage for innovation in these firms (Feranita *et al.*, 2017), recent applications of BAM through the SEW lens suggest that collaborations can act as a detrimental factor in the link between family firm and innovation (Pellegrini and Lazzarotti, 2019). The establishment of collaboration agreements may be seen *a priori* as a means of rapidly improving the efficiency with which product innovations are conducted, but the reluctance to cede control over new product's technological trajectory to external partners prompts family managers' aversion to this practice (Almirall and Casadesus-Masanell, 2010; De Massis *et al.*, 2015). This study, by introducing technological collaborations as a contingent factor into the relationship between family involvement in TMTs and product innovation efficiency, enhances our understanding regarding when and to what extent such collaborations shape product innovation processes in family firms. In doing so, we reveal that technological collaborations greatly influence family managers' SEW considerations, to the extent that such collaborations contribute to diminish firms' ability to efficiently turning innovation inputs into product innovations.

Finally, this study is also one of the first to explain and demonstrate that different collaborators lead to varying levels of family losses concerning SEW, which, in turn, result in distinctive influences on the family management-product innovation efficiency link. This is explained by the diversity of goals, knowledge and roles that characterize each collaborator when participating in product innovation processes. It builds on and extend previous family firm studies focusing on the drivers of collaborations (Classen *et al.*, 2012; Nieto *et al.*, 2015) and the manners in which collaborations influence innovation outputs (Aiello *et al.*, 2021; Ardito *et al.*, 2018). Although researchers have suggested that disparate collaborators may

entail dissimilar levels of loss of SEW endowment by family firms (De Massis *et al.*, 2015), this issue has not been empirically addressed until now.

5.3 Managerial implications

This study also provides some important practical insights. Given the compelling need to be continuously efficient in product innovation processes to survive in today's competitive world (Duran *et al.*, 2016), family firms should address the question of how to configure their TMT as a key aspect to unleash their firms' innovation potential (Matzler *et al.*, 2015). Our findings suggest that the appointment of family members in the TMT would enable effective and rapid dissemination of the intangible resources (e.g. tacit knowledge) deeply embedded in family managers and thus help family firms to innovate more efficiently.

Moreover, our study can help family managers identify and address the distinctive constraints and opportunities that emerge when operating in a collaboration context. Family firms with increased family involvement in their decision-making processes and seeking to enhance their product innovation must carefully and constantly monitor the context of the collaboration, that is, the partner type with whom the cooperation is formed, to better assess the costs and gains resulting from product innovation efficiency. Likewise, family managers must strive to overcome the shortcomings (e.g. limited absorptive capacity) that become apparent in the specific relations with collaborators. For example, whether the collaboration is with research organizations or customers, family managers would need to invest in human capital development to enhance their learning capabilities (Wu, 2012), to better recognize the value of new ideas arising from interactions with such collaborators. On the other hand, whether the collaboration is with suppliers, family firms would have to establish some kind of legal and contractual mechanisms (Lazzarotti *et al.*, 2017), such as for example, confidentiality agreements, to avoid possible knowledge leakages and opportunistic behaviors.

Additionally, this study may also offer some important suggestions to policymakers for the design of new policies and incentives aimed at boosting product innovation efficiency in family firms. For instance, they should foster the development of collaboration relationships between family firms and different partner types by offering incentives for the SEW protection and should facilitate the access of family firms to new knowledge on this subject by strengthening family business' professional associations and networks (Aiello *et al.*, 2021).

5.4 Limitations and future research

This study is not without its limitations; nevertheless, these offer new opportunities for future research. First, it relies on data from Spanish manufacturing firms. It could be argued that the political, economic and cultural context of Spain may bring about possible biases regarding the effects of family involvement in TMTs and technological collaborations on product innovation efficiency, which affect the results. Future investigations could therefore replicate our study using sampling frames other than Spanish firms to extend the validity of the results.

Second, this study is quantitative in nature and relies on survey data. Although this enables us to check the study's hypotheses on a broad and representative sample, it further constrains the scope and kind of knowledge we can gather from the results. For example, we do not have specific insights about the ways in which technological collaborations interact with family involvement in TMTs to influence firms' product innovation efficiency. This precludes us from recognizing the specific mechanisms that might explain why collaborations moderate the effect of family involvement in TMTs on product innovation efficiency. Since identifying these mechanisms could help to shed new light on the topic, future researchers should rely on qualitative research methods, such as direct interviews

with TMT members (De Massis *et al.*, 2015), to gain a better understanding of these mechanisms.

Finally, limitations with our database have made it impossible to capture key aspects such as family ownership, family CEO or gender diversity, which may shape TMTs in achieving innovation. For instance, since gender diversity contributes to enhancing social relations and developing an open working climate (Ruiz-Jiménez and Fuentes-Fuentes, 2016), it would be particularly interesting to examine how such diversity in family's TMT may affect product innovation efficiency in a collaborative environment. Future investigations could also extend the study of gender diversity beyond TMT to all firm employees to determine how family firms' teams should be composed to boost product innovation efficiency.

Note

1. Our emphasis on products rather than other types of innovation, such as patents or processes, is explained due to the following reasons. First, patents may underestimate firms' ability to innovate efficiently, not only because of many firms are unwilling to apply for patents for fear of their new ideas being appropriated (Deng *et al.*, 2013), or cannot afford the high cost of maintaining their validity or proving that the patent has been infringed (Encaoua *et al.*, 2006), but also because of patents may not be an effective means of appropriating R&D spending results (Levin *et al.*, 1987). Second, product innovation, compared to, for example, process innovation, presents particular challenges for family firms (De Massis *et al.*, 2015).

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